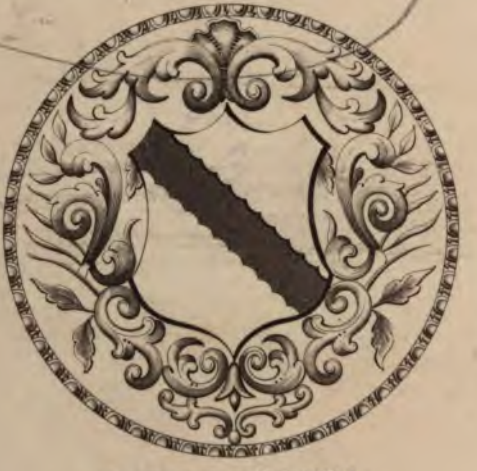

INTRODUCTORY LECTURE

DELIVERED IN

THE THEATRE

OF THE

ROYAL COLLEGE OF SURGEONS,

ON THE 8TH OF MAY 1820;

BY

B. C. BRODIE, F.R.S.

PROFESSOR OF ANATOMY AND SURGERY TO THE COLLEGE,

&c. &c.

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TO

SIR WILLIAM BLIZARD, F. R. S.

CHAIRMAN,

AND TO

THE OTHER MEMBERS

OF THE

Board of Curators

OF THE

MUSEUM

OF THE

ROYAL COLLEGE OF SURGEONS,

THIS LECTURE

IS RESPECTFULLY INSCRIBED

BY

THEIR OBEDIENT SERVANT,

B. C. BRODIE.

October 14, 1820.

about to treat; and I am also conscious of the imperfect nature of my own qualifications. At the same time I feel well assured of the indulgence which I shall meet with from the liberality of those who compose my audience, when they consider that the subject of Comparative Anatomy and Physiology is one which might well occupy the undivided attention of an active mind during a long series of years; and that the knowledge of it, which it can fall to my lot to possess, is no more than can be acquired by an individual who joins the pursuit of science with that of an arduous profession.

It is undoubtedly to be regretted, and it may be a matter of just surprise, that examples are so rare of persons who have devoted themselves to these curious and important researches; and that they should have been almost wholly abandoned to those whose thoughts are occupied, and whose leisure is invaded, by other avoca-

tions. It must be owned, however, that there is no class of mankind to whom this department of knowledge can present such powerful attractions as to the members of our own profession. To understand the natural organization and the natural functions of living bodies seems to be a necessary preliminary step to the knowledge of those changes which disease induces; and to what source can we so confidently look for any essential improvements, which may be made hereafter in medicine and surgery, as to the more enlightened notions, and more comprehensive views, which may be derived from a further cultivation of anatomy and physiology? Besides, the dignity of our profession, and its rank in society, depend in a great degree on its scientific character; and those who are anxious to uphold it in the estimation of others would do well to bear in mind, that, whenever its connexion with science is dissolved, it

must sink to the level of meaner occupations.

Anatomy and physiology ought to be regarded as inseparable from each other. The study of the former would be uninteresting and useless if pursued alone; and that of the latter would lead only to vague and absurd opinions, were it not founded on the basis of anatomical structure. But the one is much more readily brought to a certain degree of perfection than the other. An extensive acquaintance with the organization of living bodies can scarcely fail to be attained by diligent dissections; but when we extend our inquiries further into the functions of the parts which anatomy displays, we find ourselves engaged in a complicated and difficult investigation, in which much laborious research may be rewarded by no more than a scanty addition to our previous knowledge.

I need not inform you how little progress the ancient philosophers had made

in these sciences. After the revival of letters, anatomy was cultivated with much success; physiology was enriched with the discovery of the circulation of the blood: but, with this exception, it cannot be said that any very striking improvement was made in the latter science previously to the middle of the last century, when Baron Haller and Mr. Hunter set the example of a more philosophical mode of inquiry, by referring the phænomena of life to peculiar laws, instead of explaining them, as had been done before, by the mechanical and chemical laws, which operate on dead matter.

It is true that matter, when endowed with life, does not lose those properties which belong to it in its inorganic form. The living flesh is incapable of resisting the action of intense heat, or the operation of caustics. The light is refracted by the humours of the eye, as by a lens of glass or crystal. The body gravitates to the earth.

The blood flows in the vessels according to the laws of hydrostatics, and undergoes a chemical change in the lungs. But these properties are in combination with others; and the changes, which are consequent to death, shew not that they are suspended, but that they are modified and counteracted by the influence of another principle.

That the laws of life ought to be regarded as different from those which govern the changes of inorganic matter, must be acknowledged by any one who considers the essential difference which exists in the nature of the two classes of phænomena. It is the office of science first to obtain a knowledge of individual facts, and, afterwards, to reduce those facts to general principles. In proportion as the generalization is more complete, and as the number of general principles is diminished, so is science rendered more perfect. Perhaps beings of superior intelligence, and possessed of a greater range of observa-

tion, may contemplate all the immense variety of mechanical, chemical, and vital phænomena around us, as dependent on the influence of one great general law, impressed on all matter, but variously modified by the various circumstances under which it operates. But with our limited capacities we must be content with humbler views. The mechanical properties of matter must be regarded as distinct from the chemical; and neither of these, according to any right method of philosophizing, can be resorted to for the purpose of explaining what is peculiar to animal, or even vegetable life.

The properties which are impressed on living matter, are not only different from the properties of inorganic bodies, but they possess among themselves very different characters. The contractile power of muscles bears as little resemblance to nervous sensibility as it does to chemical attraction; and the propagation of volition

from the brain to distant organs, as far as we are capable of perceiving, approaches as nearly to the force of gravity as it does to the function of secretion. Yet it is supposed that the vital properties, dissimilar as they are, have a certain connecting link; that they possess something in common; that they depend on a common principle; which we may denominate the principle of life. In this conclusion we are justified by the circumstance of our finding them uniformly connected with each other. They begin to exist, they cease to exist, at the same instant; and the same supply of scarlet blood, which imparts irritability to the muscles, is the source of sensibility in the nervous system, and maintains the various glandular secretions. The term, "principle of life," if used in a sober and restricted sense, expresses not an invention of the human mind, but something which has a real existence. We know it not indeed in its

simple form, nor whether it be substance or quality; but we know it by the effects which it produces: in short, we have a knowledge of it similar to that which we possess of gravitation, electricity, or magnetism.

In general we see life combined with action, and living beings present an endless multitude of phænomena in perpetual and rapid succession. Life, however, may exist independent of any action which is evident to the senses. The egg continues unaltered, and giving no sign of an active principle within it for days and weeks; but its vitality is demonstrated by its resisting putrefaction; and when subjected to the influence of a higher temperature, it begins within itself a series of changes, which end in the developement of a new animal. The seeds and bulbous roots of plants are under parallel circumstances, and trees are frost-bound in the winter, and put forth new leaves and blossoms in the ensuing spring.

A leech, which was immersed in a cold mixture, was instantly frozen into a hard solid substance; at the end of a few minutes the animal was gradually thawed; the leech revived, and continued to live for thirty-six hours after the experiment. A curious illustration of this subject is afforded by the animalcules which occasion the blight in corn, called by farmers the *purples*, or *ear-cockle*. These animalcules, which are not to be discerned by the naked eye, become distinctly visible when moistened with a little water, and placed on a piece of glass in the field of a microscope. They are seen in constant motion, and even the ova may be detected in the act of escaping from the oviduct. If the moisture be allowed to evaporate, a dry stain is left on the glass, which is scarcely perceptible, but on the addition of a little water, the animalcules revive and move briskly as before. This experiment was repeated by Mr. Baüer with the same animalcules at

intervals of several months, during a period of more than six years, and always presented the same phænomena.

One of the most remarkable circumstances belonging to life in its active state, is, that there is a perpetual change of the materials of which animate beings are composed. The old particles separate themselves in the form of the urine, the perspiration, and the various other excretions; and to supply this waste there is a constant influx of new particles from without. Dead inorganic matter becomes endowed with life, and forms a part of the substance of the living body, from which, after a certain period, becoming again detached, it returns to be blended once more with the external world, and to obey those laws to which it was originally subjected.

The supply of new materials which is required, and the waste of old materials which takes place, varies very much, according to the state and nature of the ani-

mal. Where the vital functions are in a state of great activity, there is a demand for a larger and more frequent supply of nourishment, than under the opposite circumstances. The man, who leads a life of indolence and repose, requires a smaller portion of food than one whose habits are those of great bodily exertion. Many animals sleep through the winter months, without any nourishment whatever; and in the Philosophical Transactions there is an account of snails, which remained in a cabinet during several years, without leaving their shells, and were still living at the end of that period.

It appears that only particular forms of matter are capable of being endowed with life. Water enters largely into the composition of all living bodies. The number of other elements is not more than three or four in the vegetable, and seven or eight in the animal kingdom. In both, carbon predominates; but in the latter there is a

large proportion of nitrogen or azote, which for the most part does not exist in vegetables. The elements of which I have spoken are variously combined, and compose numerous and dissimilar textures. They undergo chemical changes under the influence of the living principle, many of which are such as are never observed to take place under other circumstances. It seems as if some of those which we have been accustomed to regard as simple substances, and as possessing nothing in common, when exposed to the action of the living organs, are capable of assuming new characters, and of being transformed into each other. The corn and hay on which a horse is fed, afford only a minute trace of phosphorus; yet phosphorus is found in abundance in the horse's urine, and in the earthy part of his bones. The egg contains a yolk floating in a transparent fluid; the latter is pure albumen; the former is albumen, with a small proportion

of oily matter; and in neither of them can lime or phosphorus be detected. Exposure to a certain degree of heat is sufficient from these simple materials to form not only the complex structure of brain and muscles, and mucous and serous membranes, but even a skeleton of bones and cartilages, which derive their solidity and firmness entirely from the phosphate of lime belonging to them.

In all animals there is a fluid, the blood, which the vital powers keep in a state of constant motion, and which seems to hold an intermediate state between the dead matter of the external world, and the substance of the living body. The sap in vegetables may be considered as corresponding to the blood in animals. Into this fluid the matter, which is to be added to the system, is first poured; and that, of which the vitality is exhausted, also makes a part of it, previously to being separated by means of the various excretions. The

blood is necessary to life, inasmuch as it supplies to the different organs that without which life cannot exist, but no further. A frog will crawl and display every mark of sensibility for an hour after the excision of the heart, and consequently after the vessels have become empty of blood. The head of a turtle was still alive, and bit at objects which were presented to it, many hours after it had been separated from the trunk. Numerous examples similar to these are furnished by the inferior animals; and even among the higher orders, we find that young animals retain their faculties for several minutes after the circulation has ceased.

Life, in its active state, exists no where except where there is access to the atmospheric air. Fish, and various mollusca, inhabit the bottom of the ocean; but their life is maintained by the air, which is dissolved in the water. The influence of the atmospheric air is even more important,

and more directly necessary to animals, than a regular supply of nourishment. But what is the nature of that influence, and in what manner does it operate? This is a difficult subject of experiment; but from the most accurate observations which have been made, it appears, that the air acts only on the circulating blood, and that the chemical changes which take place in the various orders of animals, are the following: a certain portion of oxygen gas disappears, and in its place is found an equal volume of carbonic acid. A cubic inch of carbonic acid may be resolved into a cubic inch of oxygen gas united to a certain quantity of carbon. We may therefore conclude, that on exposure of the blood to the air, carbon is evolved, and that no material or ponderable substance is absorbed. In red-blooded animals the blood, which was before of a dark red colour, becomes of a bright scarlet. Here the observations of the chemist terminate: but the physio-

logist ascertains that the dark-coloured blood is incapable of maintaining the vital functions: while, on the other hand, wherever the scarlet blood is distributed, the powers of life, in proportion as they are exhausted by exercise, are renewed, and the functions continue to be regularly performed. It is evident, that the blood in respiration acquires something of the first importance in the animal economy, and which it had not before. The effects produced by the contact of the air, are not confined to the mere separation of carbon; but in order to determine the precise nature of these effects, we require more extended observations, and a deeper insight into the nature and causes of vitality, than it will probably ever fall to the lot of man to possess.

Living beings have not an insulated existence. They have various relations to external objects, which act on them in different ways, and on which they operate

in return. Besides what are common to them and inorganic matter, there are other relations connected with their vital principle, and peculiar to themselves. Two of the most important of these have been already noticed, in treating of nutrition and respiration; but there is an endless variety of others too numerous to mention. From the lowest to the highest in the scale of animation, we observe impressions from without, exciting certain changes within, and giving rise to new actions and new phænomena. The dionæa muscipula contracts its leaves, and encloses the insect by which it is irritated. The convolvulus opens its flowers to the warmth of day, and shuts them to the cold and damp of evening. Animals are not only more susceptible of impressions than plants, but there is superadded to their organic structure that which feels and wills and reasons: and the impressions made on them excite sensations, which we suppose to be

wanting in the vegetable kingdom. I cannot accord with those who consider the inferior animals to be without sensation, because we are unable to discover in their anatomy any distinct organ adapted to the exercise of this function; at the same time we must acknowledge it to be probable, that in them sensation is obscure, and that there is only an imperfect consciousness of existence. In the higher orders sensibility is more exalted, and consciousness is complete. In them there are particular structures, admirably adapted to receive impressions from other bodies, and to convey the impressions which they make to that principle, in which the intellectual and moral faculties reside.

Even in animals, however, it is not every impression which operates on the vital functions that has a corresponding sensation. There are many which would pass altogether unnoticed, were it not for the other effects which they produce. The

presence of food in the stomach excites the secretion of gastric juice, and motions of that organ, of which we are altogether unconscious. The application of the extract of belladonna to the eyebrow causes a dilatation of the pupil of the eye, yet we have no perception of its action. A young woman received a blow on her head by which she was stunned for a few minutes: after she recovered from the immediate effects of the accident, she found herself entirely deprived of the senses of smell and taste; and she was in this state when I saw her a month afterwards. The strongest and most pungent odours produced not the slightest sensation when applied to the nostrils; but they nevertheless increased the secretion of the lacrymal glands, or, in common language, made the eyes water, as under ordinary circumstances.

Among the most obvious, though not the least remarkable, properties with which living beings are endowed, is that of being

capable, within certain limits, of resisting the influence of the external heat and cold, and of maintaining a different and peculiar temperature. In the midst of a long-continued frost, a thermometer introduced into the centre of the trunk of a tree, does not sink to the freezing point. The temperature of the interior of a tree is said to be above that of the atmosphere, if the latter be below 57 of Fahrenheit's thermometer; and if the temperature of the atmosphere rise above this point, that of the tree does not rise in the same proportion. In experiments made by Mr. Hunter, he found that when the bulb of a thermometer was introduced into the stomach of a carp, the mercury rose to 69 degrees, although the temperature of the pond in which the fish swam was no more than 65½. When the emperature of the air was 58, that of a viper's stomach was 10 degrees higher; and when a viper was placed in a temperature of 108, the heat of the stomach rose no higher

than 92½. If the bulb of a thermometer be placed under the human tongue, the mercury rises to 99; and this is equally the case in the heat of summer, and in the cold of winter. It is perhaps natural, that an explanation of these and similar phænomena should have been sought for among the numerous causes by which heat is produced in inorganic substances, and hence they have been attributed by the mechanical philosophers to the motion of the fluids, and to the friction of the particles of matter on each other; and by the chemists, to the consumption and decomposition of oxygen gas in the act of respiration. But there are many circumstances, which seem to be in contradiction to such hypotheses, and which render it questionable whether the maintenance of the vital temperature does not depend on some process peculiar to life, and whether it is not to be referred to the same source with secretion, and the other vital functions.

Throughout every part of nature we

find not only that the component parts of living bodies require to be constantly renewed, but that the individuals themselves are constructed so as to enjoy existence during only a limited period of time. On every side we see them return to the condition of dead matter, exhausted by old age, or destroyed prematurely from accidental causes. The mysterious function of generation supplies the new individuals, which are to take the place of those which have perished, and by means of which the continuance of the species is effected. But does animation ever begin to exist, where it did not exist before? Is there any process, independent of generation, by which inorganic matter can of itself become endowed with the living principle? In the interior of the earth we find the bones and shells of innumerable races of animals which have long ceased to exist. It is reasonable to conclude, that whatever has an end, must have had a beginning; yet

with respect to the higher orders, both of animals and vegetables, it is beyond a doubt that the ordinary laws of nature are insufficient for the production of a new species, and the observations of the physiologist tend to confirm the doctrine of a particular creation. With respect to the origin of those which are lower in the scale of animation, there is not, perhaps, the same degree of certainty. Hydatids are met with in the mesentery of the sheep, and flukes in the biliary vessels. Worms live in the intestines of various animals, and have been found even in those of a fœtus. In an ass or horse, which has attained a certain age, there are usually small animals resembling ascarides in external form, in a dilatation of one of the mesenteric arteries. It is difficult to understand in what manner the ova of these parasitic animals can be conveyed into the places which they inhabit, or from whence the ova can be derived: since these animals

are for the most part of a peculiar kind, bearing no resemblance to any of those which exist in other situations, nor even to each other. The hydatids of the sheep's mesentery are entirely different from the flukes of the biliary ducts, and the structure of the intestinal is not the same with that of the arterial worms. Every one is acquainted with the minute eels which are found in turbid vinegar. If any vegetable or animal infusion, after remaining for a few days at rest, be examined with a microscope, it is found full of animalcula, of singular and various forms, possessing the power of locomotion, and exhibiting other characters of life; and Mr. Needham found that these creatures shewed themselves equally under all circumstances, so that, in his latter experiments, he became indifferent whether he adopted or neglected those precautions which he at first supposed to be requisite for their production.

Facts, such as have been enumerated,

may almost induce us to believe that there is in nature the power of forming the lower orders of living beings by an equivocal generation, and that dead matter is, under certain circumstances, capable of bursting into life where life did not before exist. The following arguments may be urged on the opposite side. These same animals, when once called into existence, are endowed with the generative faculty, and bring forth young in the usual manner. Is it probable that the origin of the parents should be different from that of their offspring? Is it not more reasonable to conclude that something respecting the production of these minute creatures is concealed from our view, than that they should be produced in a manner entirely contrary to the analogy of what is observed in other beings endowed with life, whose larger size makes them more fit subjects of observation? It is not difficult to believe that their ova may be too small and insignificant to be cognizable by our senses:

that they exist where their existence is not suspected; and that it is only when conveyed by accidental circumstances, into a proper nidus, that they give birth to the young animals. The circumstances which have been already mentioned, respecting the microscopic animalcules, which occasion one species of blight in corn, show for what a length of time the living principle may remain in a dormant state, and render the last supposition highly probable.

There is no example of a being possessed of life, even in its simplest form, which is produced in its perfect state, and which has precisely the same structure and the same functions in the early as in the advanced stages of its existence. Both plants and animals contain within themselves the principles of their own growth, and of their own decay and dissolution. Compare the young oak, just bursting from the acorn, with the tree, which, after the lapse of centuries, is seen with a hollowed trunk and withered

branches, scarcely capable of bringing forth in the spring an imperfect foliage. Compare the infant child with the old man; or the caterpillar, which has just quitted its shell, with the chrysalis or butterfly. A series of constant but minute and gradual changes works these strange conversions, and maintains the identity of what might otherwise be regarded as wholly different creatures. The condition of the individual is never stationary; but his progress is not uniform; and for the most part the changes which constitute his formation and growth, succeed each other more rapidly than those which mark his approach to the termination of existence. These changes, however, striking as they are, are more limited than on the first view they appear to be. The vital powers may undergo various modifications, but essentially they are the same in the fœtus as in the adult man. The different organs may become developed, and may be called into action at differ-

ent periods; but no new organs are formed, and the rudiments of those which exist in mature age may be traced in the young animal or vegetable, as soon as it has acquired sufficient magnitude to admit of anatomical examination. The wings of the butterfly are enclosed within the integuments of the caterpillar; the lungs of the frog may be discovered in the tadpole; the testes of the man in the human fœtus. The bulbous root of the tulip contains the miniature flower and leaves of the ensuing year, completely formed; and it is said, that the future plant, perfect in all its parts, may be discovered in the germs of the mezereon. The organs and functions first developed are those which relate to the preservation of the individual; or, to use the expression of a modern physiologist, which belong to organic life. The next in order are those which belong to animal life, by means of which the individual maintains his relations to external

objects; and the last are those connected with generation and the preservation of the species. The order in which these functions decay is the reverse of that in which they are developed; and before we die we may be said, in a physiological as well as in a popular sense, to enter into a second childhood; since the only functions which continue to be performed up to the period of the extinction of our corporeal frame are those which are the first to display themselves in the infant.

There is nothing in the history of animals more worthy of notice than these changes, which are always taking place, but which are most remarkable at particular periods of their existence. That a tree should blossom in the spring; that its fruit should reach maturity in the autumnal months; that its foliage should wither and die at the approach of winter; these things may be the result of obvious causes; and the artificial summer of a hot-house will

produce the vegetation of July amid the snows of January. But the same explanation does not apply to what occurs in the higher classes of organic beings; neither does the decay and dissolution of the latter bear any actual analogy to the gradual destruction of those machines which are the result of human invention: and we in vain inquire, what is that mysterious agency which renders the human fœtus incapable of maintaining fœtal life after the lapse of forty weeks; which afterwards produces the phænomena of puberty; which, at a still later period, occasions the ossification of the arteries, and the diminution of the size and number of the capillary vessels; which limits the life of the silkworm to a single season, while that of the whale is extended to several centuries?

While, however, we contemplate these changes of properties and structure, in which every organ more or less partakes, we can scarcely fail to believe that an ani-

mal is something more than a mere assemblage of instruments, which are connected, and act in concert, with each other. We seem to have a glimpse of some one principle common to the whole system, which gives it a real individuality, and which operates on its different parts, so that they keep pace with each other in their progress towards perfection and in their subsequent decay.

I have already observed, that as the mechanical philosopher explains the mechanical changes of the material world, by ascribing them to attraction, repulsion, or elasticity, so the phænomena of life enable the physiologist to ascertain the existence of certain vital properties, to which may be referred the various changes which take place in, and are peculiar to, living bodies. The principal of these are irritability and sensibility. By irritability we mean that species of contractility which is peculiar to life, and which exists in the greatest de-

gree, but not exclusively, in the fibrous structure of the muscles. The term sensibility has been used by some modern physiologists to designate the capability of receiving, and of being acted on by, impressions; whether this be or be not attended with sensation and consciousness. The existence of sensibility is most evident in combination with a distinct nervous system; at the same time it must be observed, that it exists where nerves cannot be detected, as in plants, and even in some of the inferior animals. These two properties, irritability and sensibility, go far towards explaining the phænomena of life; and many physiologists seem to suppose that the whole of them may be traced to one or other of these sources. It does not, however, require much consideration to convince us, that this cannot be regarded as a correct opinion. Glandular secretion, exhalation, and that deposition of new matter which constitutes growth and nutrition,

cannot, except by a forced and hypothetical reasoning, be referred to either of the vital properties, which have been just mentioned. The blood in the living body, under natural circumstances, has no tendency to separate into its solid and fluid parts; but neither the same quantity of motion, nor the same temperature, nor the same exposure to oxygen, nor all of these combined, will prevent the coagulation of blood which has been drawn from the vessels. The gall-bladder, during life, does not allow the smallest particle of bile to transude through its coats; but, in a short time after death, while the organization is yet unimpaired, the bile escapes in sufficient quantity to tinge all the neighbouring viscera. There is an association of animal actions, corresponding to the association of ideas, feelings, and emotions, and which is the foundation of corporeal, as the latter is of mental habit. Do these things admit of any reasonable explanation by means of

sensibility and irritability? Do they not rather demonstrate, that our catalogue of the vital properties is not yet complete, and that we may expect it to become more ample, in proportion as, by a patient investigation of facts, and careful induction, we are enabled to render physiological science more perfect?

It has been stated, that only particular forms of matter seem to be capable of being endowed with life. The principal of these in animals are carbon, hydrogen, oxygen, and azote: and these are found united in various proportions, forming three elementary substances, which are the basis of all the great variety of animal textures. Chemists have distinguished two of these by the appellations of gelatine and albumen, of the latter of which fibrine may be regarded as a modification; and the third is the pulp of the brain and nervous system. If to these elements are added phosphate of lime, the animal oils, and a few other com-

pounds, which exist in smaller proportions, we have a view of the whole of the constituent parts of the animal machine. It is curious to observe how greatly the functions of organs vary, which possess nearly the same chemical composition. The glandular structure of the kidneys and liver, the articular cartilages, and cuticle, are all modifications of albumen. The cutis, a membrane of complex structure and of complex functions, and the simple exhaling membrane of the peritonæum, are almost wholly composed of gelatine. The principal chemical difference between the contractile fibre of a muscle and the inert fibre of a tendon is, that the former contains a smaller proportion of oxygen, and a larger proportion of azote. The cerebral pulp, the centre of sensation and the source of volition, is said by Fourcroy to differ from the albumen, of which glands and many other organs are composed, in little else than in being more highly or-

ganized and in the want of fixed alkali. Considering these circumstances, we find it no matter for surprise that the remarkable improvements in animal chemistry, which have been made of late years, should not have been attended with a proportionate advancement of the kindred science of physiology. Let us not, however, underrate the value of the former of these sciences. Whatever tends to give us more accurate notions of the composition of living bodies, cannot, at any rate, be devoid of interest; and it is not improbable that many of those distinctions, as to the nature of animal substances, of which we are unable at present to perceive the utility, may ultimately prove to be of real importance. Without the aid of the chemist, the physiologist would in vain have laboured to understand one of the principal functions of the animal economy—respiration. Little as we know of those wonderful processes of nutrition and excretion, by means

of which new materials are constantly added to our system, and the old materials are separated from it; we should have known still less had we not possessed the light which animal chemistry has shed on these subjects, and it is to the same source that we are principally to look for their further elucidation.

Although different organs present so little variety with respect to chemical composition, they differ exceedingly as to their mechanical properties and texture; and, in the present state of our knowledge, it is certainly of more importance to the physiologist to possess an accurate acquaintance with the latter than with the former. Parts, which execute dissimilar functions, are always dissimilar in their organization. The brain bears no resemblance to the muscular fibre; and there is no analogy between the fabrick of the latter, and that of the glands or investing membranes. Even where there are slight shades

of difference in the functions, there are corresponding shades of difference in the structure. The nerves which belong to the involuntary muscles are differently constituted from those which transmit the influence of volition. The skin, at the extremities of the fingers, is endowed with a nicer sense of touch than the skin in other situations, and, accordingly, the anatomist discovers in it a more refined and complex organization.

Every thing relating to this subject tends to prove, that the peculiar functions of a living organ are intimately connected with the peculiarities of its anatomical structure. This leads us to one of the most abstruse and difficult questions connected with physiological science. Are we to conclude that the phænomena of life are dependent solely on organization? that a certain mechanical arrangement of particles is in itself a sufficient cause for muscular con-

tractility, or for nervous sensibility? Immediately after a muscle is separated from the rest of the system, by means of a piece of zinc and silver, properly disposed, it may be excited to powerful contractions. Wait for a few minutes, and it is no more capable of contraction than the tendon which is annexed to it: yet, after this, a certain interval of time elapses before the organization begins to be destroyed by putrefaction. The substance of the living animal is impermeable to the various animal fluids. Let life be extinguished, and we find the bile, the urine, the aqueous humour of the eye, the blood itself, readily penetrating the membranous tunics in which it was enclosed, before we can detect the most trifling alteration in their texture. These, and other things of a similar nature, do not seem to be well explicable, except on the hypothesis of there being in living bodies something superadded to organization, without which they would be

as incapable of executing their functions as the pendulum of a clock would be of vibrating, or its wheels of revolving, if they were deprived of the spring or weight, in which the cause of their motion resides.

Not only do different organs differ from each other in their anatomical structure, but the same organ is found to consist of dissimilar parts, and the whole of the animal system may be resolved into certain elementary textures, possessing various organizations, and connected with each other in various ways. A knowledge of these elementary textures is of the first importance in anatomical and physiological, as well as in pathological science. At the same time it must be owned that there are many obstacles in the way of an accurate analysis and a perfect arrangement; and, perhaps, it is impossible to give such an account of them as may not be open to some objections. Certain parts are composed of fibres, while others are of a membranous structure; and this is the most

obvious distinction which we are led to make, at least in man, and in the animals which approach him in their nature. But animal fibres are of various kinds, which differ essentially from each other, and seem to possess only a superficial resemblance in the mechanical arrangement of the particles of matter which compose them. We distinguish fleshy fibres, which possess the property of muscular contractility; the white medullary fibres of the brain, nerves, and spinal marrow, which are concerned in the transmission of sensation and volition; and the unyielding inert fibres, which compose the tendons, ligaments, and fasciæ. The cellular membrane is composed of thin transparent flexible lamellæ, united in such a manner, as to leave intermediate spaces or cells, which communicate extensively with each other; and this texture and its modifications seem to constitute the basis of several, if not of the majority, of the other

membranes of the body: besides which, in some parts, its cells are filled with oily matter, and form the adipose substance. If to these we add the cuticle and its appendages; the substance of the glands; the bones and cartilages; and the elastic matter, which is found in certain situations; we have enumerated, at any rate, the principal component parts of our system.—Bichat, who first undertook the task of making a scientific classification of the elementary textures of the animal system, has indeed furnished us with a longer catalogue. But it is evident, that this ingenious and philosophical anatomist has considered some as distinct from each other, which are so closely allied, that they may be regarded as the same; and has considered others as simple, which are in reality compound. If the chemist is at a loss to determine on the nature of the elements to which unorganized bodies may be reduced, and finds their number become diminished

in proportion as he extends his researches further, we need not wonder that similar difficulties should present themselves in the more complex and abstruse science of living beings; and these difficulties demonstrate only the imperfection of our knowledge, and not that the attempt at anatomical analysis is ill founded.

It is scarcely more easy to make a satisfactory classification of the animal functions, than it is of animal structures. Bichat has distributed the former into three orders: 1st, Those which relate to the individual himself, which are common to all organized and living beings, plants as well as animals, and which he therefore terms functions of organic life; 2dly, Those, by means of which a living being maintains his relations to the external world, and to which, as he considers them peculiar to animals, he applies the name of functions of animal life; 3dly, The generative functions, which belong to the reproduction of

the species. But these functions are so blended with each other, that we are compelled to acknowledge that this arrangement is entirely theoretical, and that it is not one which is likely to be practically useful, or to lead to any essential improvement in the science of physiology. The heart, which is to be regarded as the principal organ of organic life, is not more necessary to the functions of one order, than it is to those of the other. The brain, which is described as the centre of animal life, has under its influence respiration, digestion, and various secretions, which belong to organic life. Such is the mutual dependence of the organs on each other, that the animal system may be said to form a circle; and in giving a history of its functions, we may with almost equal propriety begin with any one of them. We cannot, as in some sciences, set out with what is most simple, and gradually ascend to what is complicated. In considering one set of phæno-

mena, I shall often have occasion to refer to others, which I have not had an opportunity of explaining, and I shall feel it difficult to say all that I could wish to say on these subjects, without supposing my audience to be already possessed of a general information respecting them. This I am anxious to state in the commencement of the course, as an apology for many things in the subsequent parts of it, which might otherwise be attributed to a want of method, and a careless arrangement.

But perhaps such an apology may be regarded as unnecessary. As the greater part of this theatre is allotted to the members of the College, and as few are admitted into it who have not made some progress in anatomical studies, it is evident that the Board of Curators do not expect that these Lectures should be regarded as purely elementary. It is the duty of the Professor to adapt his observations as much as possible to the nature of his audience;

and I conceive, that in this place I am bound to believe, that those around me have at least a general acquaintance with the structure of the human body, and a general knowledge of the different animal functions. I know also that there are many individuals, who have entered deeply into these investigations; and of them I have to request, that they will keep in their recollection, that I do not undertake to promulgate discoveries, but only to make a selection of such facts as seem to be most striking, and best calculated to illustrate the general principles of anatomical and physiological science.

If, in this Introductory discourse, I say but little of the great philosopher, who founded the Museum of this College, and to illustrate whose labours is one of the objects for which these lectures are designed, let it not therefore be imagined, that

I can otherwise than justly estimate the magnitude of his exertions and the splendour of his achievements. The written works, which he has bequeathed to us, give but an inadequate notion of his powers; and whoever would rightly scan his character must study this anatomical collection, where the multitude of facts, which are recorded, shew the extent and minuteness of his researches; and the beautiful arrangement, which he has made of organs and functions, demonstrates how admirably his mind was adapted for accurate analysis and philosophical induction. To understand, however, all the obligations which we owe to Mr. Hunter, we must consider what was the condition, in which he found these sciences, and in what condition he left them. By his single efforts, amid the occupations and anxieties of an active professional career, he has done as much for us as has been done at a later period for a neighbouring country, by the successive

labours of Bichat and Cuvier. Since the time when Mr. Hunter gave a new direction to men's minds on these subjects, the clumsy mechanical and chemical notions of former ages have vanished; physiology has attained the rank, which it deserves to hold, amongst the highest departments of human knowledge; and surgery has risen from the place of a manual art to that of a liberal and enlightened profession.

From the contemplation of the present, the mind naturally passes to that of the future; and surely I cannot be accused of indulging in an idle reverie, if I anticipate great results from the energy and zeal with which all those sciences are now cultivated, that are in any way connected with our pursuits. Such is the present spirit of emulation, and so rapid is the march of knowledge, that whoever contents himself with the stock of information, which he has already acquired, must soon find himself outstripped by his competitors. The prac-

tical pathology of these days bears no more resemblance to the hypothetical doctrines, which once prevailed in the schools, than the astronomy of Newton does to the visions of Des Cartes. Founded on a more solid basis — composed of more durable materials, the fabrick of modern pathology already assumes the appearance of a regular and substantial structure. Let those, who labour to complete the important work, be assured that they can be fitted for the task, which they have undertaken, only by having previously acquired correct notions of the organization of living bodies, and the laws of vitality. Let them bear in mind how much of the genius of Boerhaave, and Brown, and Cullen, has been lost to the world, because they attempted to explain the principles of disease, without having first rightly comprehended the natural state of the animal economy.

THE END.

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